DOCUMENT RESUME

ED 290 631 SE 048 862

AUTHOR Weaver, Dave; And Others
TITLE Function Plotters for Secondary Math Teachers. A MicroSIFT Quarterly Report.
INSTITUTION Northwest Regional Educational Lab., Portland, Oreg.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE Aug 87
CONTRACT 400-86-0006
NOTE 17p.; For product descriptions, see SE 048 861.
PUB TYPE Book/Product Reviews (072) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Algebra; Analytic Geometry; Calculus; *Computer Assisted Instruction; *Computer Graphics; *Computer Software Reviews; Computer Uses in Education; Functions (Mathematics); *Graphs; Mathematics Curriculum; Mathematics Education; *Mathematics Instruction; Mathematics Materials; Secondary Education; *Secondary School Mathematics; Trigonometry

ABSTRACT

This report examines mathematical graphing utilities or function plotters for use in introductory algebra classes of more advanced courses. Each product selected for inclusion in this report is able to construct the graph of a given equation on the screen and serves as a utility which may be used by the student for an open-ended exploration of a mathematical concept or by the teacher as a demonstration tool. The products are classified into one of the following types: (1) general purpose graphing utilities; (2) demonstration tools; and (3) special utility programs. In general it was felt that the positive aspects of function plotters far outweigh the negative. The ability to automate the tedious process of plotting the graph of an equation enables students to examine more equations in a shorter time. Teachers are able to spend less time sketching graphs on the overhead or blackboard. The zoom and scroll features found in many function plotters offer capabilities which cannot be duplicated manually. The report is organized into four sections including general features, algebra, coordinate geometry and trigonometry, and calculus. (PK)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED290631

THE Northwest Regional Educational Laboratory

TECHNOLOGY PROGRAM

FUNCTION PLOTTERS FOR SECONDARY MATH TEACHERS

A MicroSIFT Quarterly Report

August 1987

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
X This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Jerry D Kirkpatrick
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

by

Dave Weaver
Monica Nelson
Anne Batey

Technology Program
Northwest Regional Educational Laboratory
101 S.W. Main Street, Suite 500
Portland, Oregon 97204
503/275-9500

Sponsored by

OERI Office of Educational Research and Improvement
U.S. Department of Education

This publication is based on work sponsored wholly, or in part, by the Office of Educational Research and Improvement (OERI), Department of Education, under Contract Number 400-86-0006. The content of this publication does not necessarily reflect the views of OERI, the Department, or any other agency of the U.S. Government.

SE 048 863

BEST COPY AVAILABLE

FUNCTION PLOTTERS FOR SECONDARY MATH TEACHERS

A MicroSIFT Quarterly Report

August 1987

by

Dave Weaver
Monica Nelson
Anne Batey

Technology Program
Northwest Regional Educational Laboratory
101 S.W. Main Street, Suite 500
Portland, Oregon 97204
503/275-9500

INTRODUCTION

In this report we examine mathematical graphing utilities or function plotters for use in introductory algebra classes or higher. Each product selected for inclusion in this report adheres to the following criteria:

- The product must be able to construct the graph of a given equation on the screen
- The product must serve as a utility which may be used by the student for an open-ended exploration of a mathematical concept or by the teacher as a demonstration tool

Products not included in our consideration were tutorials or drills which provided instruction on how to graph mathematical equations, utilities which constructed bar, pie, picture or line graphs, scientific graphing utilities which primarily accept sets of ordered pairs for graphing, data analysis and curve fitting, and graphics utilities which enable the user to create computer-generated drawings.

After reviewing all of the more than thirty products identified, it became apparent that products could be classified into one of the following types:

- **General Purpose Graphing Utilities**--These packages generally consist of a single graphing utility accompanied by a user's manual. The instructional value of these products is a function of how the teacher chooses to make use of the package. They may either be used by the teacher as a demonstration tool or by the student in an open-ended exploration. In either case the teacher is responsible for preparing the setting by organizing a presentation or preparing a handout which guides the student through the use of the software toward a better understanding of a graphing concept. For example, a teacher wishing to use such a package to show how a particular constant influences a family of equations, would need to choose the appropriate form of the equation and select values for the constant that would make good examples ahead of time. During the classroom demonstration, these equations would generally be entered manually.

- **Demonstration Tools**--These packages are designed explicitly for demonstration purposes and contain preprogrammed demonstrations of selected math concepts. For example, such a product may graph a family of five equations in the form of $y=mx+b$ where b is held constant and m is varied. Another example might be a demonstration of the derivative where the program displays the graph of a function such as $f(x)=\sin x$ and then draws the tangent line at various points, calculates its slope and plots the slope on a second graph on the same screen. Such a demonstration quickly shows how $f'(x)=\cos x$.

- **Specialized Utility Programs**--These packages consist of a collection of graphing utility programs, each of which is designed for a very specialized function. For example, such a package may have one utility program for studying linear equations and another for exploring quadratics. These packages are intended for use by individuals or small groups of students and include reproducible worksheets or have an accompanying text or workbook.

In addition to the general types described above, other common factors were also noticed:

- Virtually all of the packages graph linear, quadratic, polynomial, exponential, logarithmic and trigonometric functions on the Cartesian coordinate system. Most frequently, the students were prompted with y = _____ from which they entered the function to be graphed in terms of x.

- Few of the products were able to properly label the graph in the same way teachers would expect and demand from their students. Commonly, the resulting graphs would not have the origin or the axes labeled. Although tick marks are used along the axes to indicate the scaling, the tick marks are very seldom numbered. Generally, the scaling numbers appear only at the end of the axes. Most of the products were able to display the equation of the graph somewhere on the screen but generally it was nowhere near the actual graph. In cases where more than one graph appeared on the same coordinate system, it was common for only the last equation to appear. The ability to label an individual point was seldom seen. This general lack of adequate labeling sets a poor example for student.

- While math teachers are aware that, in theory, the graphs of functions are a smooth curve, the use of computer graphing utilities could easily lead a student to believe otherwise. Because of the resolution of microcomputers, it is impossible for any of these products to make a smooth graph. In addition, the use of color will often accentuate the jagged appearance of the graph as well as slightly shift the graph to make it appear inaccurate. It is important that students viewing computer-generated graphs understand these difficulties.

Although some of these observations may seem critical, the positive aspects of function plotters far outweigh the negative. The ability to automate the tedious process of plotting the graph of an equation enables students to examine more equations in a shorter time. Teachers need to spend less time sketching graphs on the overhead or blackboard with their backs to their students. The zoom and scroll features found in many function plotters offer capabilities which cannot be duplicated manually. Numerous other features discused later in this report enhance their value.

There is evidence that we can expect continued and possibly increasing development of new function plotter programs in the future. Currently this class of software is typified by a group of older reliable stand-bys challenged by a few bright new stars. Of those highlighted and recommended for preview, eight had copyrights 1982 to 1984 and the remaining seven were copyrighted in 1986 and 1987. As the older products become obsolete because of increased graphing capabilities of the newer computers, demand for replacement products will increase. In addition, it appears as though we are in the middle of a development spurt. Over a third of the titles reviewed were copyrighted 1986 or newer and in several cases we were only able to examine preliminary versions of new products to be published later this year.

ABOUT THIS REPORT

Because the various products we examined are more appropriate for use in one math subject than in others, we organized this report into four separate sections. 1) A General Features section provides a basic descriptive information list on all of the products considered in our study along with a comparison of the features common to all products. Three subsequent sections; 2) Algebra, 3) Coordinate Geometry & Trigonometry, and 4) Calculus compare those features useful for demonstrations and explorations within those subject areas. Each sections also highlight those products which our reviewers recommend for preview. Keep in mind, some of the products highlighted in the higher topics of coordinate geometry, trigonometry and calculus may also useful tools for algebra but, would include features often not used in algebra. Such products are marked with an asterisk (*) by the title.

More detailed descriptions of each product and references to other published reviews can be found in a companion report titled Product Descriptions: Function Plotters for Secondary Math Teachers.

1. GENERAL FEATURES

FUNCTION PLOTTERS PRODUCT LIST

KEY: G General Purpose Graphing Utility
D Demonstration Tool
S Collection of Specialized Graphing Utilities

Title	Publisher	Computer	Grade	Copyright	Price	Type
Advanced Mathematics	MECC	Apple II + e GS 48K	9- col.	1981	$35.00	G
Arbplot	Conduit	Apple II + e c 48K	9-12	1982	$125.00	S
CactusPlot:A Math. Utility	CactusPlot Co., The	Apple II + e 48K, IBM PC 128K	9-12	1987	$60.00	G
Calcu-Plot	Human Systems Dyn.	Apple II + e c 48K	11-col.	1983	$150.00	G
Calculus Illustrated	Wadsworth Publ Co.	Apple II + e c 64K	11-12	1986	$21.50	S
Calculus Toolkit, The	Addison-Wesley	Apple II + e c 48K, IBM PC	11-12	1984	$149.95	S
Computer Graphing Exper.:						
Vol. 1: Algebra I & II	Addison-Wesley	Apple II + e c 32K	8-12	1982	$80.00	S
Vol. 2: Trig. Functions	Addison-Wesley	Apple II + e c 32K	10-12	1982	$80.00	S
Vol. 3: Conic Sections	Addison-Wesley	Apple II + e c 32K	10-12	1982	$80.00	S
Vol. 4: Calculus	Addison-Wesley	Apple II + e c 32K	11-12	1985	$80.00	S
Discovery Learning in Trig.	Conduit	Apple II + e c 48K, IBM PC 192K	10-12	1986	$75.00	S
Electronic Blackboard:						
Algebra	COMPress	Apple II + e c 48K	8-12	1983	$95.00	D
Function Plotter	COMPress	Apple II + e c 48K	10-12	1983	$50.00	G
Trigonometry	COMPress	Apple II + e c 48K	10-12	1983	$50.00	D
Equation Math	MECC	Apple II + e 128K	9-12	1987	$55.00	G
Function Graphing	Kamischke	Apple II + e c GS 48K	8-12	1985	$90.00	G
Graph-Calc	COMPress	IBM PC 128K	12-col.	1986	$75.00	G
Graph Plotter	SRA	Apple II + e c 48K	10-12	1984	$40.00	G
Graphing Equations	Conduit	Apple II + e c 48K	8-12	1983	$45.00	G
Graphing Trig. Func.	Bergwall	Apple II + e c 48K, IBM	10-12	1985	$49.00	D
Green Globs & Graph. Eq.	Sunburst Commun.	Apple II + e c GS 48K, IBM PC/PCjr 128K	9-12	1986	$65.00	G
Heath Graph Maker	Collamore/DC Heath	Apple II e c GS, 128K	8-12	1988	?	G
MathCAD	Addison-Wesley	IBM PC/XT/AT, 512K	10-Col.	1987	$249.00	G
Mathgrapher	HRM Software	Apple II + e c 48K, C-64	8-12	1984	$69.00	G
MCP Function Plotter	MCP	Apple II + e c 64K	8-12	1986	$49.00	G
PC Graphics	Dynacomp	IBM PCjr 128K	9-12	1986	$49.95	G
SuperGraph	Ventura Educ. Sys.	Apple II + e c 48K	8-12	1986	$59.95	G
SuperPlot	EduSoft	Apple II + e c GS 64K	8-12	1985	$49.95	G
Surfaces for Multivari. Cal.	Conduit	Apple II + e c 48K	11-col	1981	$65.00	D
TecMath:						
Differentiation	Technical Educ. Con.	Apple II + e c GS 48K	11-12	1987	$60.00	D
Graphing	Technical Educ. Con.	Apple II + e c GS 48K	11-12	1987	$60.00	G
Integration	Technical Educ. Con.	Apple II + e c GS 48K	11-12	1987	$60.00	D
Taylor Poly, Approx.	Technical Educ. Con.	Apple II + e c GS 48K	11-12	1987	$60.00	D

EXPLANATION OF GENERAL FEATURES-- There are certain features and capabilities which we believe are important and should be considered when choosing a graphic utility package for classroom use. When examining these products we asked: Is it possible to

label the x and y axes?	Axes	change scale and redraw or zoom?	Zoom
label the origin?	Orig	relocate the origin and redraw or scroll?	Scrl
label individual points?	Indv	how many lines can be displayed on the same graph?	Lins
display numbers along the axes, not just at the end points?	Numb	display the equation of the line on the screen with the graph?	Equa
change the tick interval?	Invl	enter the equation just as you would write it?	Nota
show a grid?	Grid		

TABLE OF GENERAL FEATURES

KEY: - No • Yes

Title	Axes	Orig	Indv	Numb	Invl	Grid	Zoom	Scrl	Lins	Equa	Nota
Advanced Mathematics	-	-	-	-	•	-	•	•	∞	•	-
Arbplot	-	•	-	-	•	-	-	•	2	•	-
CactusPlot: A Mathematics Utility	-	-	•	-	•	-	•	•	5	•	-
Calcu-Plot	-	•	-	•	•	-	-	-	1	•	-
Calculus Illustrated	-	-	-	•	•	-	•	•	∞	•	-
Calculus Toolkit, The	-	-	-	-	•	•	•	-	1	•	-
Computer Graphing Experiments											
Vol. 1: Algebra I & II	-	•	-	-	•	-	•	-	1	•	-
Vol. 2: Trig. Functions	-	•	-	-	•	-	-	-	∞	•	-
Vol. 3: Conic Sections	-	•	-	-	•	-	-	-	∞	•	-
Vol. 4: Calculus	-	•	-	-	•	-	-	-	∞	•	-
Discovery Learning in Trig.	-	-	-	-	-	-	-	-	∞	•	•
Electronic Blackboard											
Algebra	-	-	•	-	•	-	•	-	∞	•	-
Function Plotter	-	-	-	•	•	-	-	-	∞	•	-
Trigonometry	-	-	-	-	•	-	•	-	∞	•	-
Equation Math	-	-	-	-	•	•	•	-	4	•	-
Function Graphing	-	-	•	-	-	-	•	•	∞	•	•
Graph-Calc	-	-	-	-	•	-	•	-	2	•	-
Graph Plotter	•	-	-	•	-	•	-	-	∞	-	-
Graphing Equations	-	-	-	•	•	•	-	-	∞	•	•
Graphing Trigonometric Functions	•	-	-	•	-	•	•	-	∞	•	-
Green Globs & Graphing Equations	-	-	-	-	•	•	-	-	∞	•	•
Heath Graph Maker	-	-	-	•	-	-	•	•	∞	•	•
MathCAD	•	•	•	•	-	•	•	•	∞	•	•
Mathgrapher: A Complete Graphing Util.	-	-	-	-	•	•	•	•	∞	•	-
MCP Function Plotter	-	-	•	-	•	-	•	•	20	-	•
PC Graphics	•	-	-	-	•	-	•	•	3	•	-
SuperGraph	-	-	-	-	•	-	-	-	∞	-	-
SuperPlot: Function Graphing Program	•	-	-	•	•	-	•	•	5	•	•
Surfaces for Multivari. Calculus	-	-	-	-	-	-	-	-	1	-	-
TecMath											
Differentiation	•	-	-	-	-	-	-	-	1	•	-
Graphing	•	-	-	-	•	-	•	-	∞	•	-
Integration	•	-	-	-	•	-	-	-	1	•	-
Taylor Polynomial Approximations	•	-	-	-	•	-	-	-	∞	•	-

2. ALGEBRA

Beyond the features described above there are other features to consider when selecting software for use in an algebra class. For these products we asked: Is it possible to

display f(x) for a given x?	RGD	plot sets of points?	PTS
graph vertical lines?	VRT	graph absolute value functions?	ABS
graph the inverse of a given function?	INV	graph inequalities by shading the region?	REG
enter equations in parametric form?	PAR	calculate f(x) for a given x?	RGC
calculate x for a given f(x)?	DOM	calculate the y-intercepts?	INT
calculate slope of line between 2 points?	SLP	calculate the coordinates of the intersection of 2 lines?	COR

TABLE OF FEATURES USEFUL IN ALGEBRA

KEY: - No • Yes

TITLE	RGD	PTS	VRT	ABS	INV	REG	PAR	RGC	DOM	INT	SLP	COR
Advanced Mathematics	-	-	•	•	-	-	•	-	-	-	-	-
Arbplot	-	-	-	•	•	-	-	-	-	-	-	-
CactusPlot: A Mathematics Utility	•	•	•	•	-	-	•	•	•	•	-	•
Calcu-Plot	-	-	-	•	-	-	-	-	-	-	-	-
Calculus Illustrated	-	-	-	•	-	-	-	-	-	-	-	-
Calculus Toolkit, The	•	-	-	•	-	-	•	-	-	-	-	-
Computer Graphing Experiments												
Vol. 1: Algebra I & II	-	-	-	•	-	•	-	-	-	-	-	-
Vol. 2: Trig. Functions	-	-	-	•	-	-	-	-	-	-	-	-
Vol. 3: Conic Sections	-	-	•	-	-	•	-	-	-	-	-	-
Vol. 4: Calculus	-	-	-	•	•	-	•	-	-	-	-	-
Electronic Blackboard												
Algebra	-	•	•	•	-	•	-	•	-	•	•	-
Function Plotter	-	•	-	•	•	-	-	-	-	-	-	-
Equation Math	•	-	•	•	-	•	-	•	-	-	-	-
Function Graphing	•	•	-	•	•	-	•	•	-	-	-	-
Graph-Calc	-	-	-	•	-	•	•	-	-	-	-	-
Graph Plotter	-	-	-	•	•	-	•	-	-	-	•	-
Graphing Equations	-	-	•	•	•	-	-	-	-	-	-	-
Green Globe & Graphing Equations	-	-	•	•	-	-	-	-	-	-	-	-
Heath Graph Maker	-	•	•	•	-	•	-	-	-	-	-	•
MathCAD	-	•	•	•	-	-	-	•	•	•	-	-
Mathgrapher	-	-	-	•	-	-	-	•	-	-	•	-
MCP Function Plotter	-	-	-	•	-	-	-	-	-	-	-	-
PC Graphics	-	-	•	-	-	-	-	-	-	-	-	•
SuperGraph	-	-	•	•	-	-	-	-	-	-	-	-
SuperPlot	-	-	-	•	-	-	-	-	-	-	-	-
TecMath												
Differentiation	-	-	•	•	-	-	-	-	-	-	-	-
Graphing	-	-	-	•	-	-	•	-	-	-	-	-
Integration	-	-	-	•	-	-	-	-	-	-	-	-

HIGHLIGHTED PRODUCTS FOR ALGEBRA--In alphabetical order.

Computer Graphing Experiments Volume 1: Algebra One & Algebra Two--Addison-Wesley, Apple II + e c, 32K, grades 8-12, 1982, $80.00--As the title implies, this package is designed for experimentation and discovery. Although the software is limited to the particular algebra concept under investigation and somewhat basic, the worksheets make this package valuable. Students can explore using the computer as a vehicle, and be reinforced through worksheets. This is the package for students who are learning how to reason, evaluate and make conclusions.

Computer Graphing Experiments Volume 3: Conic Sections--Addison-Wesley, Apple II + e c 32K, grades 10-12, 1982, $80.00--Conic sections are often hard for students to visualize and hard for teachers to draw; this package solves both problems. This package zeros in on conic sections, their equations, corresponding graphs and the detailed information included with each type. Experimentation is the theme and creative students can designs using conic section.

Electronic Blackboard: Algebra--COMPress, Apple II + e c, 48K, grades 8-12, 1983, $95.00--"Clear" and "simple" describe "Electronic Blackboard: Algebra" by COMPress. Because this package uses a familiar simulated blackboard, students can be at ease with working on a computer. Students are guided through the basics of graphing step-by-step in a sequential process. Confidence is built as students move from the Display mode to the Interactive mode. For the beginner in graphing, this user-friendly program is ideal.

Equation Math--MECC, Apple II + e GS, 128K, grades 9-12, 1987, price $55.00--For the student who needs all required information on one screen without being confused, this program is it. This three-level package will give students confidence in graphing complex functions with simplicity. After working with it, students will be eager to explore the many avenues of graphing. "Equation Math" provides all the basics students need to know in graphing.

3. COORDINATE GEOMETRY & TRIGONOMETRY

For the packages designed for use in coordinate geometry and trigonometry classes we asked: Is it possible to

graph quadratic relations (circles, hyperbolas, etc.)?	REL
show the asymptotes?	ASM
enter equations in the form x=f(y)?	INV
graph on a polar coordinate system?	POL
translate or shift a graph?	SHF
reflect a graph through a line?	REF
rotate a graph about a point?	ROT

TABLE OF FEATURES IN COORDINATE GEOMETRY & TRIGONOMETRY

KEY: - No • Yes

TITLE	REL	ASM	INV	POL	SHF	REF	ROT
Advanced Mathematics	•	-	•	•	•	-	-
Arbplot	•	-	•	•	-	-	-
CactusPlot: A Mathematics Utility	•	•	-	•	-	-	-
Calcu-Plot	•	-	-	•	-	-	-
Calculus Toolkit, The	•	-	-	•	•	-	•
Computer Graphing Experiments							
Vol. 1: Algebra I & II	-	-	-	-	-	-	-
Vol. 2: Trig. Functions	-	-	-	•	-	-	-
Vol. 3: Conic Sections	•	-	•	-	-	-	-
Discovery Learning in Trig.	-	•	-	•	•	-	-
Electronic Blackboard							
Algebra	•	•	-	-	-	-	-
Function Plotter	•	•	-	-	•	•	-
Trigonometry	-	•	-	-	-	-	-
Equation Math	•	-	-	•	-	-	-
Function Graphing	-	-	-	-	-	•	-
Graph-Calc	•	•	•	•	-	-	-
Graph Plotter	•	-	-	•	-	•	•
Graphing Equations	•	-	•	-	-	-	-
Graphing Trigonometric Functions	-	-	-	-	-	-	-
Green Globs & Graphing Equations	•	-	•	-	-	-	-
Heath Graph Maker	•	•	•	-	•	•	•
MathCAD	•	-	•	-	-	-	-
Mathgrapher: A Complete Graphing Util.	•	-	-	•	-	-	-
MCP Function Plotter	•	-	-	-	-	-	-
PC Graphics	•	•	•	•	-	-	•
SuperGraph	•	-	-	-	-	-	-
TecMath: Graphing	-	-	-	•	-	-	-

HIGHLIGHTED PRODUCTS FOR TRIGONOMETRY & COORDINATE GEOMETRY--In alphabetical order.

Electronic Blackboard: Function Plotter *--COMPress, Apple II + e c, 48K, grades 10-12, 1983, $50.00--This simulated blackboard puts students at ease as they find themselves viewing a familiar screen. In this three-level system, "Function Plotter" and Function Symmetries have an appropriately restricted set of commands. For instance, "Function Plotter" only allows for inverses and asymptotes, while Function Symmetries allows for all translations. Students will want to explore.

Graph Plotter *--SRA (Science Research Associates), Apple II + e c, 48K, grades 10-12, 1984, $40.00--For students who wish to venture out on their own and try new things, "Graph Plotter" offers them all they need. Providing students with a wide selection of commands, functions can be rotated, flipped and reversed all in different colors! Menus are well-organized so students will not become bewildered as they play with this interactive package.

Mathgrapher: A Complete Graphing Utility *--HRM Software, Apple II + e c, 48K, Commodore 64, grades 8-12, 1984, $69.00--Respect for "Mathgrapher" grows as students discover its capabilities. It is simple enough for a beginning algebra student yet challenges even the advanced student. Those who learn by a visual approach and those who learn by hands-on experimentation are equally accommodated. With three menus, each performing more complex operations, students of all talents can find their place.

MCP Function Plotter *--Microcomputer Curriculum Project, Apple II + e c, 64K, grades 8-12, 1986, $49.00--"Function Plotter" is a comfortable and user-friendly package. Not only can students enter traditional functions, but it allows many manipulative options such as zooming, scrolling, moving the cursor to any location on a curve and more. Students can have fun with this one! Pull-down menus set this package apart from others.

PC Graphics *--Dynacomp, IBM PC/jr, 128K, grades, 1986, $49.95--"PC Graphics" is designed for students who are eager to explore and who desire to see a graph of any conceivable function. If the data needs to be altered, students can interrupt what they are doing and make necessary changes. "PC Graphics" can benefit a wide range of students. The screen contains enough information for students to begin unassisted graphing.

* denotes those products also useful in algebra.

4. CALCULUS

For the packages designed for use in calculus classes we asked: Is it possible to

graph on a three-dimensional system?	3-D
display the tangent to a curve at a point?	TNG
calculate the slope of the tangent?	SLO
graph the derivative function?	DER
display a region under a curve divided into n rectangles?	REC
shade the region under a curve for a given interval?	SD1
shade the region between two curves?	SD2
calculate the Riemann sum?	INT
graph the sum of two functions?	SUM
graph the composite of two functions?	COM
fit a curve or a line to a set of points?	FIT
calculate the zeros using Newton's Method?	NWT

TABLE OF FEATURES USEFUL IN CALCULUS

KEY: - No • Yes

TITLE	3-D	TNG	SLO	DER	REC	SD1	SD2	INT	SUM	COM	FIT	NWT
Advanced Mathematics	-	-	-	-	-	-	-	•	-	-	-	-
Arbplot	-	•	•	•	•	•	-	•	-	-	-	•
CactusPlot: A Mathematics Utility	-	•	•	•	-	•	•	•	•	-	-	-
Calcu-Plot	-	-	-	•	-	-	-	•	-	-	-	-
Calculus Illustrated	-	•	•	•	•	•	-	•	-	-	-	•
Calculus Toolkit, The	•	•	•	•	•	-	-	•	-	-	-	•
Computer Graphing Experiments Vol. 4: Calculus	•	•	•	•	•	-	-	•	-	-	-	-
Function Graphing	-	-	-	•	•	-	-	•	•	•	-	-
Graph-Calc	-	-	-	•	-	-	-	-	-	-	-	-
Graph Plotter	-	•	•	•	-	•	-	•	-	-	-	-
Green Globs & Graphing Equations	-	-	-	-	-	-	-	-	•	-	-	-
MathCAD	-	-	•	•	•	-	-	-	•	•	-	•
Mathgrapher: A Complete Graphing Util.	-	-	•	-	•	-	-	•	-	-	-	-
MCP Function Plotter	-	-	-	-	-	-	-	-	•	•	•	-
PC Graphics	•	-	-	•	-	-	-	-	-	-	-	-
Surfaces for Multivari. Calculus	•	-	-	-	-	-	-	-	-	-	-	-
TecMath												
Differentiation	-	•	•	•	-	-	-	-	-	-	-	-
Graphing	-	-	-	-	•	-	-	-	-	-	-	-
Integration	-	-	-	-	•	•	-	•	-	-	-	-

HIGHLIGHTED PRODUCTS FOR CALCULUS – In alphabetical order.

Arbplot-- Conduit, Apple II + e c, 48K, grades 9-12, 1982, $125.00--"Arbplot" covers a lot of calculus topics. There are not many graphing packages that can compete with "Arbplot's" capabilities. Not only is it comprehensive but "Arbplot" goes as far as giving technical information which enables students to write their own programs. The entire program is menu driven and simple to follow.

CactusPlot: A Mathematics Utility *--CactusPlot Company, The, Apple II + e, 48K, IBM PC, 128K, grades 9-12, 1987, $60.00--For the versatility and quality this package provides, "CactusPlot" stands above the others. It plots the graphs quickly, provides tables and gives solutions to equations commonly seen in math classes ranging from algebra through calculus. Students can manipulate any function directly from the graphing program. All this is reasonably priced and retains the easy-to-use format needed by many students.

Calculus Illustrated--Wadsworth Publishing Company, Apple II + e c, 64K, grades 11-12, 1986, $21.50--Calculus topics are not easy to understand yet with the help of "Calculus Illustrated" students will be able to grasp many difficult concepts. The easy-to-use menu allows investigation of a number of ideas including limits, antiderivatives and derivatives. The clear and accurate graphs eliminate the frustration of graphing complex functions. Discovery problems are included in the manual.

Calculus Toolkit, The--Addison-Wesley, Apple II + e c, 48K, IBM PC, grades 11-12, 1984, $149.95--The explorations, explanations and insights "Calculus Toolkit" provides are astounding. The variety of programs included in this package cover all the essentials of a calculus course. Programs for graphing functions, differential equations, investigating vector fields and complex numbers are enhanced by the computer's graphic capabilities. Students can learn complicated material in a simple manner.

TecMath: Differentiation--Technical Educational Consultants, Apple II + e c GS, 48K, grades 11-12, 1987, $60.00--For the student who needs an in-depth study of differentiation, this is the package. What it lacks in broadness, it makes up in its detailed preview of the topic of the derivative. Students can grow with this package as they unravel the many options available. Students are kept on task and will have a sense of purpose.

TecMath: Integration--Technical Educational Consultants, Apple II + e c GS, 48K, grades 11-12, 1987, $60.00--This function plotter is easy to use from the first screen on. It examines the topic of integration at a very in-depth level. Once familiar with the system, students can enter a function quickly with special keystroke commands. For the student in calculus who wants to explore and learn or just become familiar with the integral, this package provides all he/she needs.

* denotes those products also useful in algebra.

PRODUCER LIST

Addison-Wesley Publishing Company 415/854-0300
2725 Sand Hill Road, Menlo Park, CA 94025
MARKETING POLICIES--Preview: 30-day approval basis. Requests for examination materials are granted by local representatives. Discount: Individual discount prices. Warranty and Returns: Special authorization required.

Bergwall Educational Software 800/645-1737
106 Charles Lindbergh Blvd., Uniondale, NY 11553
MARKETING POLICIES--Preview: 21-day preview. Discount: $20 quantity discount, lab pack and site licensing available. Warranty and Returns: 30-day money back guarantee, replace free of charge if defective through normal use.

Cactus Software - The CactusPlot Company 602/945-1667
1442 North McAllister, Tempe, AZ 85281
MARKETING POLICIES--Preview: 30-day money back preview. Discount: Five disk discount. Warranty and Returns: After 30 days, $15 per disk replacement.

Collamore/D.C. Heath 800/235-3565
125 Spring St., Lexington, MA 02173
MARKETING POLICIES--Preview: 30-day preview with purchase order. Discounts: Lab packs, site licensing and network versions available. Call 800/235-3565. Warranty and Returns: Damaged disks replaced for $8 for up to two years after purchase.

COMPress 603/764-5831
P.O. Box 102, Wentworth, New Hampshire 03282
MARKETING POLICIES--Preview: 30-day preview and evaluation plan. Discount: For multiple copy purchase, discount for more than five copies available. Warranty and Returns: Return with written explanation, receive free replacement copy.

Conduit 319/335-4100
University of Iowa, Oakdale Campus, Iowa City, IA 52242
MARKETING POLICIES--Preview: 30-day period. Discount: Orders for 10 or more titles receive 20% discount. Warranty and Returns: 30-day warranty; $10.00 for a replacement copy of each diskette.

Dynacomp, Inc. 800/828-6772
1064 Gravel Road, Webster, NY 14580
MARKETING POLICIES--Preview: 30-day full refund return. Discount: Large quantity discount available. Warranty and Returns: 1 year return--$5.

EduSoft 800/EDU-SOFT or 415/548-2304
P.O. Box 2560 Dept. 52, Berkeley, CA 94702
MARKETING POLICIES--Preview: 30-day preview policy. Discount: None. Warranty and Returns: After 30-days, $5 to replace a disk. Others: Site license available for $45.

HRM Software 800/431-2050 or 914/769-6900

175 Tompkins Avenue, Pleasantville, NY 10570

MARKETING POLICIES--Preview: 30-day free preview. Discount: $1000 or more, receive free program of choice. Warranty and Returns: Return with invoice for full refund or replacement.

Human Systems Dynamics 800/451-3030

9010 Reseda Blvd. Suite 222, Northridge, CA 91324

MARKETING POLICIES--Preview: 10-day preview. Discount: Quantity discounts available (call 1-800-451-3030). Warranty and Returns: 10-day full refund return policy, after 10-days, $10 for replacement. Others: Free technical advice for any program..

Kamischke, E. 616/929-0722

1220 Reads Run, Traverse City, MI 49684

MARKETING POLICIES--Preview: 30 days upon request. Discount: Site licensing included with standard school ($90) and programmer's ($100) package. Warranty and Returns: Lifetime warranty.

MECC 612/481-3500

3490 Lexington Avenue North, St. Paul., MN 55126

MARKETING POLICIES-- Preview: 30-day preview. Discount: Members can receive up to 40% off listed price. Warranty and Returns: Free replacement.

Microcomputer Curriculum Project (MCP) 319/273-6259

Price Laboratory School, University of Northern Iowa, Cedar Falls, IA 50613-3593

MARKETING POLICIES-- Preview: None. Discount: Volume discounts available, up to 15%, lab packs available. Warranty and Returns: None.

SRA/Science Research Associates. 800/621-0476 or 312/984-7384

155 North Wacker Drive, Chicago, IL 60606

MARKETING POLICIES-- Preview: 30-day free preview available. Discount: Quantity discounts available up to 15% for 250 or more units ordered. Warranty and Returns: 90-day full refund, after 90-days, $5 a disk.

Sunburst Communications USA-800/431-1934, Canada-800/247-6756

39 Washington Avenue, Pleasantville, NY 10570-9971

MARKETING POLICIES-- Preview: 30-day preview. Discount: Individual discounts available on large orders. Warranty and Returns: Lifetime replacement warranty.

Technical Educational Consultants 516/681-1773

76 North Broadway Suite 2010, Hicksville, NY 11801

MARKETING POLICIES-- Preview: Free 30-day examination. Discount: Individual discounts available. Warranty and Returns: 90-day full refund policy.

Ventura Educational Systems 805/499-1407

3440 Brokenhill Street, Newbury Park, CA 91320

MARKETING POLICIES-- Preview: 30-day preview. Discount: 50 or more of different titles 15% discount. Warranty and Returns: Full money return or replacement if damaged from normal use.

Wadsworth Inc. School Div.Dpt-S85 415/595-2350
10 Davis Drive, Belmont, CA 94002
MARKETING POLICIES-- Preview: Preview upon request, 30-days. Discount: If used as a training program, receive net price. Warranty and Returns: Replacement disk free when defective disk sent in.

Northwest Regional Educational Laboratory

Dr. Robert R. Rath, Executive Director
Dr. Ethel Simon-McWilliams, Associate Director

The Northwest Regional Educational Laboratory (NWREL) is an independent, nonprofit research and development institution established in 1966 to assist education, government, community agencies, business and labor in improving quality and equality in educational programs and processes by:

- Developing and disseminating effective educational products and procedures
- Conducting research on educational needs and problems
- Providing technical assistance in educational problem solving
- Evaluating effectiveness of educational programs and projects
- Providing training in educational planning, management, evaluation and instruction
- Serving as an information resource on effective educational programs and processes including networking among educational agencies, institutions and individuals in the region

Programs

Center for Professional Development
John Mahaffy, Director

Desegregation Assistance Center
Ethel Simon-McWilliams, Director

Education and Work
Larry McClure, Director

Evaluation and Assessment
Gary Estes, Director

Literacy and Language
Stephen Reder, Director

Multifunctional Resource Centers
Lois Fiaui, Jose Licano-Palma, Directors

Pacific Regional Educational Program
John Kofel, Director

R&D for Indian Education
Joe Coburn, Director

Rural Education
Steve Nelson, Director

School Improvement
Bob Blum, Director

Technology
Don Holznagel, Director

Program Support

School Improvement Coordination
Rex Hagans, Director

Institutional Development and Communications
Jerry Kirkpatrick, Director

Finance and Administrative Services
Joe Jones, Director

Board of Directors

Ed Argenbright
Montana Superintendent of Public Instruction

C. J. Baehr
Manager, Hawaii Interactive Television System

Chuck Bailey
Education Director
Washington State Labor Council AFL/CIO

Robert D. Barr
Dean, OSU/WOSC School of Education
Oregon State University

Jacob Block (Secretary-Treasurer)
Superintendent
Missoula Elementary District (Montana)

Raina J. Bohanek
Teacher
Coeur d'Alene School District (Idaho)

Frank B. Brouillet
Washington Superintendent of Public Instruction

Joanne Crosson
Director, Educational Relations
Pacific Northwest Bell

E. E. (Gene) Davis
Superintendent
Anchorage School District (Alaska)

William Demmert
Alaska Commissioner of Education

Jean M. Dobashi
Teacher
Kauai High/Intermediate School (Hawaii)

Verne A. Duncan
Oregon Superintendent of Public Instruction

Jerry L. Evans
Idaho Superintendent of Public Instruction

Earl Ferguson
Superintendent
Klamath Falls Union High School District (Oregon)

Joseph Haggerty
Principal
Blanchet High School
Seattle, Washington

James E. Harris
Beaverton School Board (Oregon)

Richard L. Hart
Dean, College of Education
Boise State University (Idaho)

Martys Henderson
Teacher
Fairbanks School District (Alaska)

Jerry Jacobson
Superintendent
Idaho Falls School District (Idaho)

John Kohl
Dean, College of Education
Montana State University

Dale Lambert
Teacher
Eastmont School District (Washington)

Joe McCracken
Superintendent
Lockwood Elementary District (Montana)

Richard McCullough
Superintendent
La Grande School District (Oregon)

Zola McMurray
Business Woman
Lewiston, Idaho

G. Angela Nagengast
Teacher
Great Falls High School (Montana)

Gloria B. Nelson
Director of Education
Guam Department of Education

Edie Orner
Teacher
Corvallis School District (Oregon)

Barney C. Parker (Chairman)
Superintendent
Independent District of Boise (Idaho)

Fred Pomeroy
Superintendent
Kenai Peninsula Borough Schools (Alaska)

Dennis Ray
Superintendent
Walla Walla School District (Washington)

Doris Ray
Fairbanks School Board (Alaska)

Henry Sablan
Superintendent of Education
Commonwealth of Northern Mariana Islands

Tauese Sunia
Director of Education
Government of American Samoa

Charles Toguchi
Superintendent
Hawaii Department of Education

Daro Weital
Director, Office of Education
Federated States of Micronesia

Doyle E. Winter (Vice Chairman)
Superintendent
Educational Service District 121
Seattle, Washington

Pacific Region Educational Center:
1164 Bishop Street, Suite 1409
Honolulu, Hawaii 96813
(808) 533-1748

Rocky Mountain Office:
1860 Lincoln Street, Suite 320
Denver, Colorado 80295
(303) 830-3675

NWREL Headquarters
101 S.W. Main Street, Suite 500
Portland, Oregon 97204
503-275-9500
SOURCE STLØ58

Alaska Offices
Goldstein Building, Room 506
130 Seward Street
Juneau, Alaska 99801
(907) 586-4952

650 West International Airport Road
Anchorage, Alaska 99502
(907) 563-3174